



Evaluation Of Protective Gloves Used in the Collision Repair Industry



Diana Ceballos¹, Stephen Whittaker^{1,2,3}, Michael Yost¹, Carolyn Reeb-Whitaker², Jackelin Tran¹, Janice Camp¹, Russell Dills¹

¹University of Washington, Department of Environmental and Occupational Health Sciences

²Safety & Health Assessment & Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries

³Local Hazardous Waste Management Program, Public Health- Seattle & King County

Introduction

Painters in auto body shops are exposed to many hazardous chemicals, particularly isocyanates, used in hardeners of two- part paint systems and present in high concentrations in the final “clear” coat. While inhalation of isocyanate aerosols and vapors has long been recognized as a primary cause of work- related asthma, growing evidence suggests that skin exposure may be an important route of exposure.

The American Thoracic Society estimated that 15% of adult asthma may be attributable to occupational exposure.¹ Workers' compensation data² from 1995 to 2002 reports the Washington auto repair industry exhibited the second highest rate of compensable State Fund asthma claims, almost ten times the overall incidence rate. Additionally, the rate for all asthma claims (compensable and non-compensable) filed in this industry was three fold higher than the overall.

Only limited and conflicting information is available on the effectiveness of protective gloves for spray painters, focused largely on comfort, elasticity, and solvent resistance rather than resistance to isocyanates. This is not surprising, because conventional permeation testing methods do not work with complex mixtures or materials that polymerize or cure, like isocyanate-based paint.

A novel device, called a permeation panel, was developed for field- testing protective clothing. The panel tests several glove materials at once and simulate actual spray painting operations. Test results will provide valuable recommendations for glove type, thickness, and frequency of use to help prevent skin exposure and work-related asthma.

Methods

Gloves most commonly used in the collision repair industry were tested against a commonly used clear coat formulation using the permeation panel, as follows: Thin latex (powder free Gloveworks Industrial Latex Ammex 5mil, TLF46100), thin nitrile (Xtreme Nitrile Industrial Gloves, powder free, Ammex 5mil, XNPF46100), thick nitrile (8mil M-Safe 3277, powdered free, industrial grade), thick latex (15mil M-Safe 3418, examination glove, powdered free).

Temperature, relative humidity, loading of the dry paint, thickness of the paint, and other parameters were recorded for all experiments.



Figure 2. Permeation Panel (note top flat surface, 8 permeation cells C1-C8, and 12 loading port locations L1-L12). Loading ports were used to determine the mass of dry clear coat deposited during the spray application (post-pre filter weight). Loading ports were built by mounting pre-weighed PTFE filters in 50x50 mm² thick aluminum foil with 1 inch diameter openings.



Figure 3. Permeation panel is sprayed by the same spray painter in a temperature controlled spray booth (70F). The panel is sprayed just like a car part with 4 parts clear, 1 part hardener, and 1 part reducer.

Results

Fixed Time Experiments: 30 minutes post-spraying

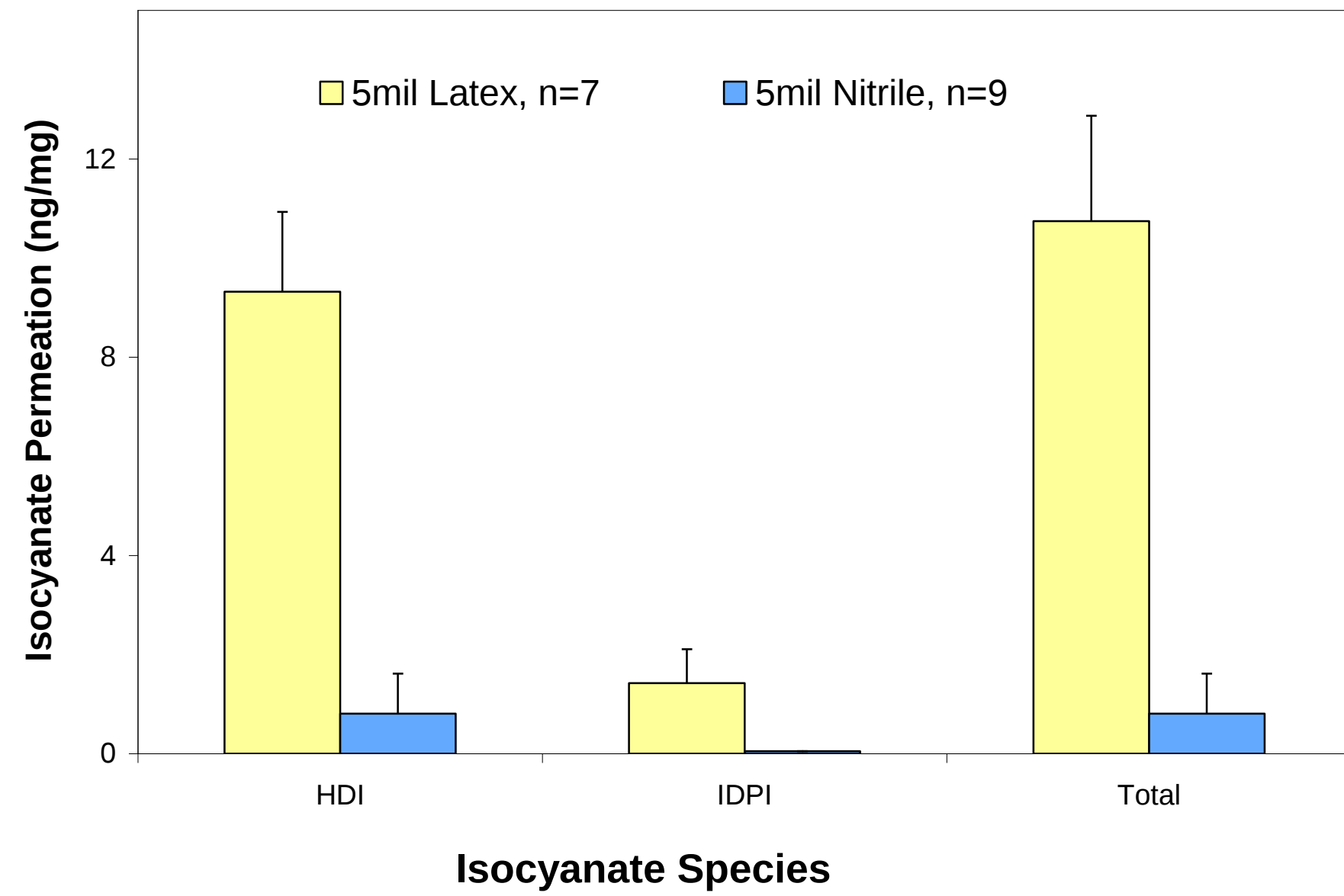


Figure 4. Isocyanate permeation results for thin latex and thin nitrile gloves for the different isocyanate species: 1,6-hexamethylene diisocyanate or HDI, isophorone diisocyanate or IPDI, and total isocyanates which is the sum of HDI, IPDI, HDI oligomers, and IPDI oligomers. Permeation was normalized by the dry clear coat loading at 30 minutes post-spraying. Note that thin latex has considerably higher permeation for HDI and IPDI, while thin nitrile has no breakthrough for IPDI monomer. HDI permeates more than IPDI even though they are at the same concentration in the paint mixture (0.24%w/w in hardener). There was no detectable oligomer permeation.

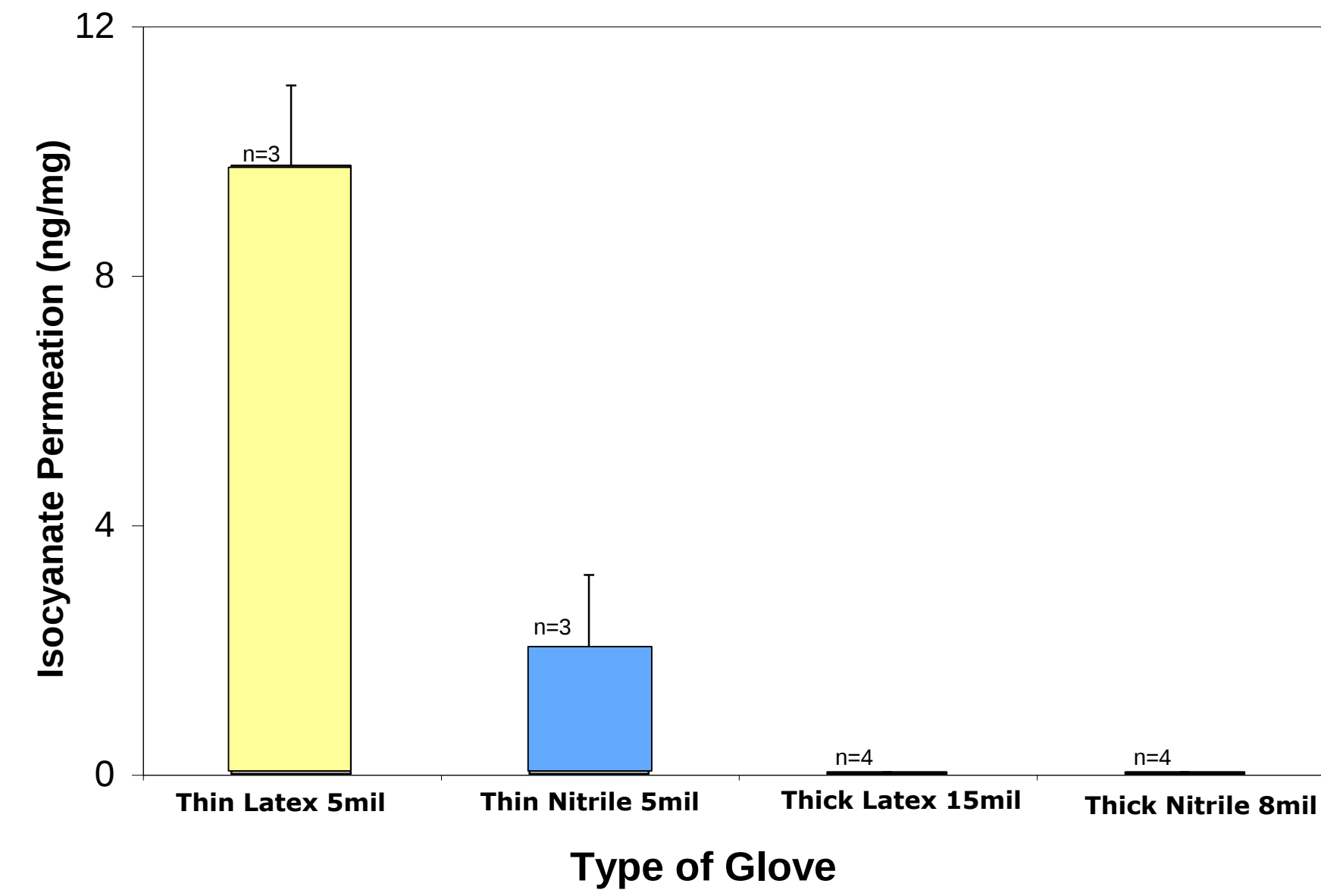


Figure 5. Total isocyanate permeation for thin and thick latex and nitrile gloves. Permeation results are normalized by the dry clear coat loading at 30 minutes post-spraying. Thin gloves resulted in isocyanate breakthrough while thick gloves did not.

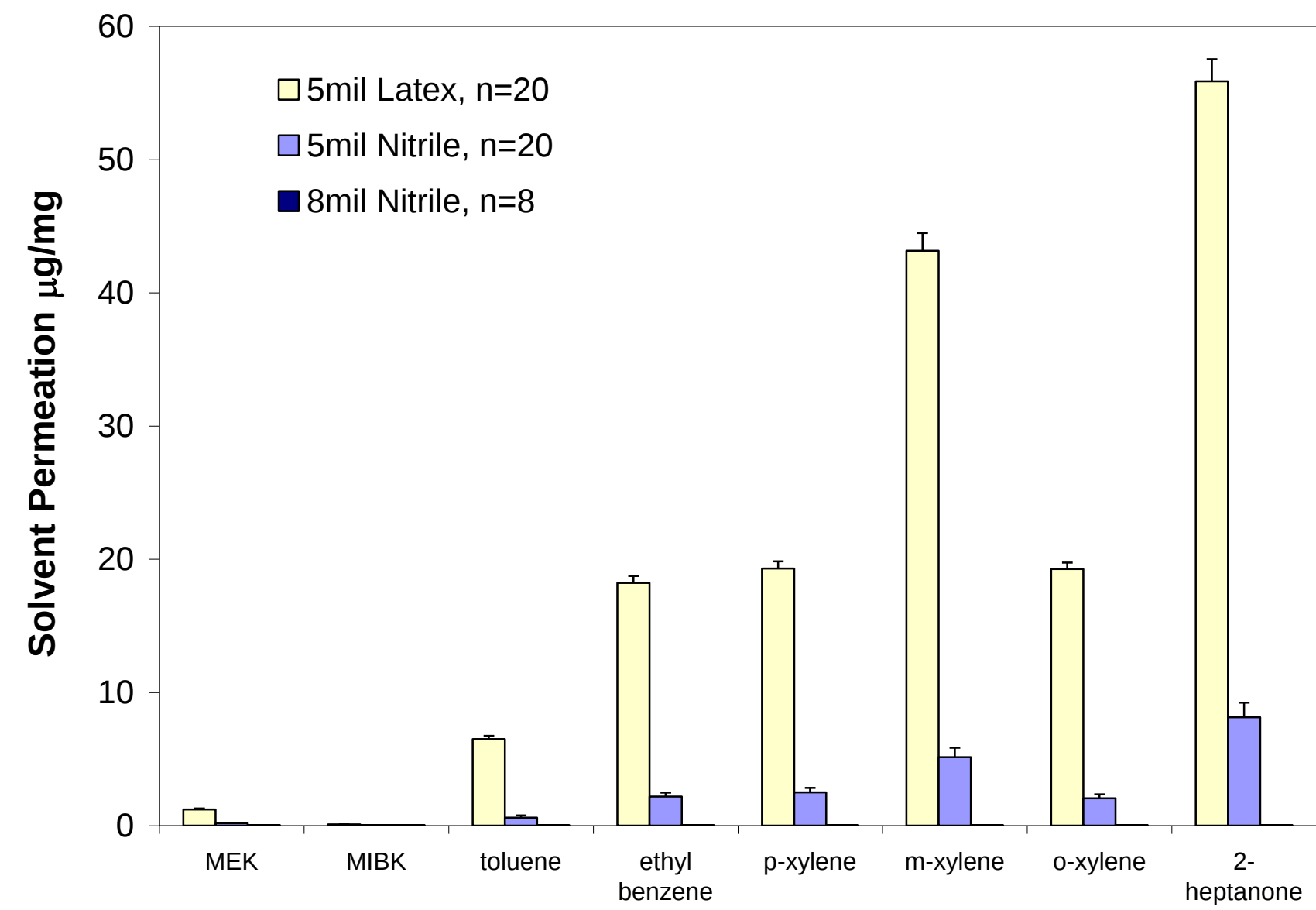


Figure 6. Solvent permeation for thin and thick latex and nitrile gloves. Permeation results are normalized by the dry clear coat loading at 30 minutes post-spraying. Latex gloves resulted in more solvent breakthrough than nitrile gloves for all solvents. Thick nitrile gloves had no breakthrough of solvents.

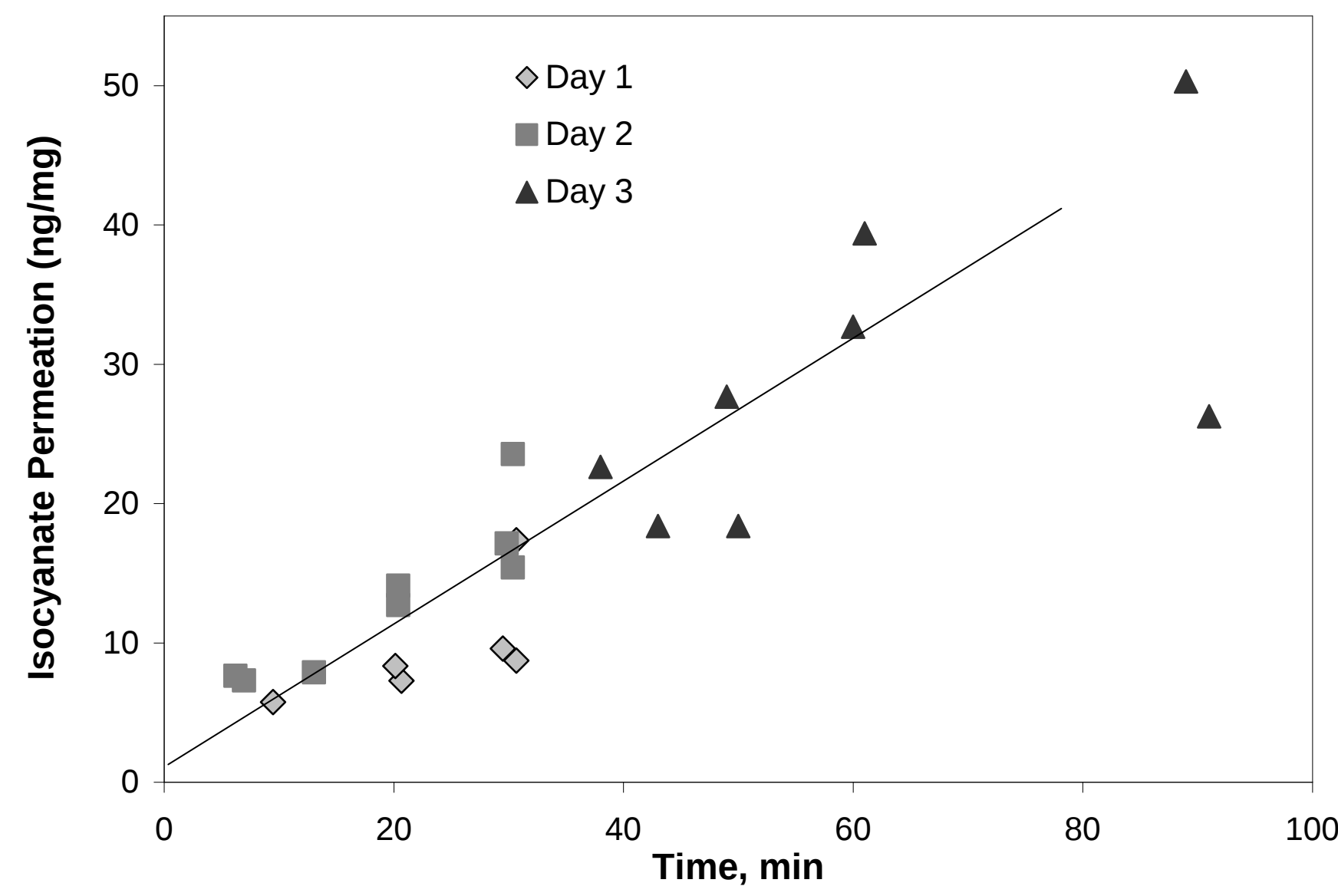


Figure 7. Total Isocyanate Permeation over time for 5mil latex gloves during 3 day sampling. Time was measured after the second spray application. Permeation results are normalized by the mass of dry clear coat loaded. Permeation was evident 5 minutes after spraying of clear coat. Intercept indicates immediate breakthrough of the isocyanates. Slope of 0.43ng/mg-min, R²=0.77, suggests an isocyanate permeation rate of 2.9ng/cm²-min.

Summary

✓For low volatility and low water solubility compounds, like isocyanates, there is not enough information to be able to select protective clothing based on protection. No standard method to measure permeation is available for complex mixtures that polymerize, like isocyanate paints.

✓The permeation panel succeeded in providing isocyanate and solvent permeation data under spray application conditions.

✓Loading variability of the coating was fairly homogeneous (17 panel experiments with a 13%CV within and among panels) and below typical hand spray painting variability (20%CV).

✓HDI monomer permeated more than IPDI monomer, even though they had the same concentration in the paint mixture. No isocyanate oligomer permeation was detected (oligomer limit of detection was 0.5µg/sample).

✓Most popular gloves among spray painters (thin latex) permeated isocyanates and solvents significantly more than thin nitrile gloves after 30 minutes post-spraying (typical length of time gloves are use in the field).

Recommendations to Spray Painters

•Thick nitrile gloves (≥8mil) are the most recommended for spray painting and mixing.

•Thin nitrile gloves (5mil) provide some protection but need to be changed every 20 minutes.

•Thin latex gloves (5mil) allow immediate breakthrough of isocyanates so they are not recommended.

Current Work (funded by NIOSH grant R01 OH009364-01)

Permeation panel experiments to test other gloves and coveralls with several paint formulations using a robotic applicator to minimize loading variability down to 2%. More tests are needed to understand charcoal cloth storage stability.

The best gloves and coveralls from the panel experiments will be tested by spray painters to assess their efficacy under typical work conditions.

Key informant interviews to influential members of the collision repair industry to understand motivators and barriers to the use of protective gloves. Focus groups of spray painters to identify educational opportunities in the use of protective gloves.

Create educational material for painters and managers in the collision repair industry to increase and improve the use of protective gloves and coveralls.

References: ¹American Thoracic Society: American Thoracic Society statement: Occupational contribution to the burden of airway disease. Am. J. Respir. Crit. Care. Med. 167(5):787–797 (2003). ²SHARP (2003). Work-Related Asthma in Washington State: A Review of Worker's Compensation Claims from 1995-2002. Safety & Health Assessment & Research for Prevention (SHARP) report 64-6-2003. Olympia, Washington. December 2003.

Acknowledgements: Thanks to the UW Environmental Health Lab for chemical analysis and Mark Beaudreau, Ming-Yi Tsai, Jeff Brandon, and Neal McConnell for ideas and help building the panel. Thanks to Prof. Michael Morgan for support and mentoring and Eric Coker and Danielle Parette for their help in the field. Thanks to spray-painting training facilities and autobody shops for their knowledge and spraying of the panel. Thanks to Majestic Glove for kindly providing protective glove samples.

Funding: This study was supported in part by the UW Department of Environmental and Occupational Health Sciences, National Occupational Research Agenda Project, Chevron student-training fund, and the National Institute for Occupational Safety and Health (NIOSH).